

# Food security experiences of displaced North Korean households

Soo-Kyung Lee<sup>§</sup> and So-Young Nam

Department of Food and Nutrition, Inha University, 100 Inharo, Namgu, Incheon 402-751, Korea

**BACKGROUND/OBJECTIVES:** Food shortage situation in North Korea has gained much interest, however food insecurity caused by the food shortage in North Korean households has not been much investigated. This study examined food security experiences and food consumption pattern of displaced North Korean households currently living in South Korea.

**SUBJECTS/METHODS:** Food security experience among 51 North Korean households living in South Korea was examined using the Household Food Insecurity Access Scale (HFIAS) in three time points: immediately before childbirth, immediately before leaving North Korea, and immediately before entering South Korea. Meal/snack consumption frequencies and food diversity were also examined.

**RESULTS:** Food security situation was the worst at the time of immediately before leaving North Korea with the average HFIAS score of 10.05. The households that were food insecure, they tended to be "severely" insecure. Although majority of the subjects reported having three or more meals a day, food diversity in their diet was very low with the average food diversity score of 2.17 immediately before childbirth and 1.74 immediately before leaving North Korea. Their diet appeared to heavily rely on grain and vegetable.

**CONCLUSIONS:** This study is one of few that specifically examined food security of North Korean households with a pre-developed scale, and that demonstrated food security situation at different time points in quantified terms. Replicating this study with different groups of North Korean households for different time points would allow more complete understanding of impacts of food shortage. Food diversity score could provide a good way to examine changes of food consumption occurring to North Koreans in the process of adaptation. More attention to the changes occurring during adaption to South Korea should be given to understand the process and impact and to prepare public nutrition policy for the re-unified Korea.

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## INTRODUCTION

The food shortage in North Korea became apparent beginning in the early 1990s and worsened during the latter part of the 1990s. Although the situation is believed to have improved lately, North Korea still has an inadequate food supply [1]. Effects of this food shortage has been clearly and vividly demonstrated in the high prevalence of stunting, wasting, and underweight among North Korean children [2,3]. The latest report in 2012 [4] showed that stunting and wasting among North Korean children were still very high at 27.9% and 4%, respectively, which confirms that the food shortage in North Korea remains severe.

Previous research [5-10] on how the food shortage in North Korea has affected adults suggested that, compared to South Korean counterparts, North Korean adults were generally shorter and showed worse nutritional and health status. Most of these studies obtained data from North Koreans who were displaced, as few studies had been able to recruit North Koreans actually living in North Korea. Further, the quantity and quality

of data on North Korean adults are much lower compared to data on children [2-4,11,12], as national surveys on North Korean children have been conducted every two years since 1998. Some of these national surveys, however, included women of child-bearing age (20-50 y.o.) with young children under the ages of two or five, depending on the survey. These surveys examined anthropometric measurement, anemia, and food consumption of the women. The malnutrition rate of women, as determined by measurement of mid-upper arm circumference (< 22.5 cm), decreased from 32% in 2002 to 23.2% in 2012, whereas the anemia rate also decreased from 34.7% in 1998 to 31.2% in 2012 [4]. Although the malnutrition situation among young North Korean women has apparently slightly improved, it is still dire compared to the situation in South Korea [12]. Therefore, the food shortage in North Korea has significantly affected the health and nutritional status of not only children but also adults.

Until now, the food shortage situation in North Korea has been defined based on food supply rather than food consumption. For example, the joint report [1] on food security in North

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<sup>§</sup> Corresponding Author: Soo-Kyung Lee, Tel. 82-32-860-8121, Fax. 82-32-862-8120, Email. [skleenutrition@inha.ac.kr](mailto:skleenutrition@inha.ac.kr)

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Korea by the WFP, FAO, and UNICEF indicated that 297,000 MT of cereals and 137,000 MT of nutritional supplements were required for 6.1 million North Koreans. Few studies, however, examined the food security situation experienced at different time points by North Korean households, such as at different years or in different places during the journey to a new home after leaving North Korea. In addition, the food security situation of North Koreans has not been examined using internationally developed scales.

As mentioned above, food consumption by North Korea women has been examined as a part of a national survey. According to 2002 [2] and 2012 [4] reports, diets consumed by North Korean women of child-bearing age remained unchanged during that 10 year period. Specifically, their diets were heavily dependent on cereals with some added vegetables, beans, and oils; consumption of eggs and dairy foods was scarce. To better understand the effects of food shortage and to devise intervention strategies, more research on food consumption is needed according to time and place.

Research on malnutrition in North Korea resulting from food shortage is important for North Korea as well as South Korea. Past as well as current incidences of malnutrition could become risk factors for nutrition-related non-communicable diseases in the future, as re-unification of the Koreas will allow North Koreans sudden access to affluent environments [13-15]. This would likely and significantly burden the public health and medical systems of a re-united Korea. North Koreans currently living in South Korea constitute a unique and valuable natural experimental group for investigating such a possibility as well as developing future public nutrition policy. A constant flow of 1,500-3,000 North Koreans have annually entered South Korea. As of 2012, 24,614 North Koreans (7,576 men and 17,038 women) are living in South Korea [16]. Research on displaced North Koreans has actively been conducted in many areas, and nutrition research is not an exception. Many of the previously mentioned research conducted with North Koreans living in China [5-12] have shown that the diets of North Koreans in North Korea living in China were inadequate. Displaced North Korean children and adolescents have also shown different food and nutrient consumption patterns than their South Korean counterparts [17,18].

This study examined the food security experiences of displaced North Korean households using the Household Food Insecurity Access Scale (HFIAS), and HFIAS scores were compared to food consumption patterns of mothers in the households.

## SUBJECTS AND METHODS

### *Subjects*

This cross-sectional study recruited North Korean women living in Seoul and Incheon, South Korea. To date, a significant portion (38%) of North Koreans who entered South Korea was relocated to Seoul and Incheon area [16], therefore targeting these two areas for this study was appropriate. This study was conducted as part of a larger one investigating North Korean children and their parents, and subjects of this study were women with a child between the ages of 6 and 18. Since the list of North Korean individuals living in South Korea is highly

confidential, recruiting of subjects for this study was conducted using the snowball method, a non-random sampling procedure. This research (protocol No. 2008 1456) was approved by the IRB prior to the beginning of the study and subjects signed an informed consent form after being informed about this study.

### *Study variables and methods*

Data were collected in two steps. A pre-tested questionnaire was administered to the subjects. The research team carefully screened the completed questionnaire and followed up with a telephone or face-to-face interview, if necessary.

Food security and food consumption information was obtained at three time points: immediately before childbirth, immediately before leaving North Korea, and immediately before entering South Korea. Food consumption information immediately before childbirth was obtained to reflect the nutritional and health status of the child. Further, the three time points were not chronologically aligned for those households in which a baby was born in a nation other than North Korea. In this case, a family would have left North Korea first, had a child, and then entered South Korea. Therefore, the time point immediately before childbirth included experiences either in North Korea or another nation, whereas the time point immediately before entering South Korea solely included experiences in a nation other than North Korea.

### *Food security*

Food security is achieved "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life", as defined in the 1996 World Food Summit. This study examined household food security using the Household Food Insecurity Access Scale (HFIAS) [19]. HFIAS is thought to be a well-developed scale to determine food security at the household level in food insecure environments [19,20] and has been applied in various countries [21-24]; therefore it was suitable for this study. Since HFIAS was originally developed in English, the questions were translated first to Korean and then back into English; differences between the original and back-translated version were minimized. The Korean HFIAS was tested in a small group of North Koreans and revised based on their inputs. HFIAS questions were asked at three time points: immediately before childbirth, immediately before leaving North Korea, and immediately before entering South Korea.

HFIAS was analyzed based on the guidelines provided by the developers [19]. HFIAS scores range from 0 to 27, with higher scores indicating lower food security status. Food security levels were categorized as follows: food secure, mildly food insecure, moderately food insecure, and severely food insecure. HFIAS results were compared to food consumption data at each time point in order to confirm that HFIAS properly reflected reality.

### *Food consumption*

Food consumption patterns of North Korean mothers were examined at the three aforementioned time points based on food diversity scores. Food diversity scores have been linked to food security and the nutritional status of children and adults [26-28]. North Korean women were asked to recall whether they

had breakfast, lunch, dinner, and snacks, and usual foods consumed as each meal or snack. Based on this information, number of meals, snacking, and food diversity scores were determined. Food groups for food diversity score utilized the food groups provided by the Korean Dietary Reference Intakes [25] based on the assumption that the identical genetic background shared by North and South Koreans implies similar nutritional needs. Food items recalled by the subjects were manually assigned to six food groups: grain group, meat, fish, egg, and bean group, vegetable group, fruit group, milk and dairy group, and fat and sweets group. Food diversity scores were calculated based on the five major food groups, excluding the fat and sweets group. A similar approach has been used previously [4,21].

#### General characteristics

Body weight and height measurements of subjects at four time points (pre-pregnancy, immediately before leaving North Korea, immediately before entering South Korea, and current) were obtained, and a subjective body shape question was provided for those who could not recall their weight and/or height. Education level, working status, and household income were also asked.

#### Statistical analyses

Statistical analyses were conducted using IBM SPSS ver 20.0 (SPSS Inc., IBM corp., NY, USA). Basic statistics included means

and standard deviation, frequency, and percentages. Mean comparison among time points were conducted using Mann-Whitney's U test, Brown-Forsythe test, and post-hoc multiple comparisons by Tamhane. Distribution differences were examined using Fisher's exact test. Significance level was determined based on a two-sided p-value of 0.05.

## RESULTS

#### Basic characteristics

A total of 51 North Korean women participated in this study, however, each question item in the questionnaire was answered by a different number of women. For example, 43 were able to provide their current weight, but only 21 women provided their pre-pregnancy weight. North Korean women came to South Korea through diverse routes, but all traveled through a third nation after leaving North Korea and before entering South Korea. Some women gave birth to their child in North Korea and left after, whereas others left North Korea to a third nation and then had their child (Table 1).

Subjects were generally normal or thin with an average BMI of 21.96. Body weight of subjects tended to be lowest immediately before leaving North Korea. Most commonly, the highest education level attained was high school level. Approximately half of the women reported to be working, and the most frequent household income category was between 0.5-1.0 million Korean won per month (Table 1).

**Table 1.** General characteristics of displaced North Korean women

	Pre-pregnancy	Immediately before		Current
		Leaving North Korea	Entering South Korea	
Anthropometric information				
Weight (kg, M ± SD)	(n = 21) <sup>1)</sup> 52.95 ± 4.86	(n = 25) 50.68 ± 6.57	(n = 35) 51.74 ± 6.41	(n = 43) 54.18 ± 8.21
Height (cm, M ± SD)	(n = 38) 155.95 ± 4.03	(n = 26) 157.00 ± 4.36		
BMI (M ± SD)	(n = 21) 21.85 ± 1.63	(n = 24) 20.53 ± 2.56		(n = 38) 21.96 ± 2.23
Subjective body shape (n(%))	(n = 39)	(n = 21)	(n = 16)	
Very thin	3 (7.7)	7 (33.3)	1 (6.3)	
Thin	7 (17.9)	6 (28.6)	6 (37.5)	
Normal	24 (61.5)	7 (33.3)	7 (43.8)	
Heavy	5 (10.2)	1 (4.8)	2 (12.5)	
Socioeconomic status				
Education (n(%))				(n = 46)
Elementary school				1 (2.2)
Middle-high school				14 (30.4)
High school				26 (56.5)
College or more				5 (10.9)
Working status (n(%))				(n = 46)
Current working				24 (52.2)
Not working				22 (47.8)
Household income (n(%))				(n = 49)
0.5 million KRW or less				4 (8.2)
0.5 - 1 million KRW				31 (63.3)
1 - 2 million KRW				1 (2.0)
1.5 million KRW or more				13 (26.5)

<sup>1)</sup> The number of participants who provided information.

**Table 2.** Food security of displaced North Korean women

	Immediately before			Statistical test
	Childbirth	Leaving North Korea	Entering South Korea	
HFIAS <sup>1)</sup> (M ± SD)	(n = 45) <sup>2)</sup> 2.62 ± 4.88 <sup>3)</sup>	(n = 41) 10.05 ± 9.76 <sup>b</sup>	(n = 46) 0.67 ± 2.43 <sup>a</sup>	24.459 <sup>4)</sup> ***
Food security status (n(%))	(n = 48)	(n = 42)	(n = 48)	44.667 <sup>5)</sup> ***
Food secure	34 (70.8)	11 (26.2)	41 (85.4)	
Food insecure	14 (29.2)	31 (73.8)	7 (14.6)	
Mildly	1 (2.1)	0 (0.0)	2 (4.2)	
Moderately	4 (8.3)	4 (9.5)	2 (4.2)	
Severely	9 (18.8)	27 (64.3)	3 (6.3)	
Place of childbirth				
North Korea	(n = 21)	(n = 21)	(n = 23)	4.190*
HFIAS (M ± SD)	4.19 ± 5.86 <sup>a</sup>	4.29 ± 5.42 <sup>a</sup>	0.61 ± 2.35 <sup>b</sup>	
Food security status (n(%))	(n = 23)	(n = 22)	(n = 23)	16.550*
Food secure	12 (52.2)	9 (40.9)	21 (91.3)	
Food insecure	11 (47.8)	13 (59.1)	2 (8.7)	
Mildly	1 (4.3)	0 (0.0)	0 (0.0)	
Moderately	3 (13.0)	2 (9.1)	1 (4.3)	
Severely	7 (30.4)	11 (50.0)	1 (4.3)	
Other	(n = 24)	(n = 20)	(n = 23)	41.054***
HFIAS (M ± SD)	1.25 ± 3.39 <sup>a</sup>	16.10 ± 9.72 <sup>b</sup>	0.74 ± 2.56 <sup>a</sup>	
Food security status (n(%))	(n = 25)	(n = 20)	(n = 25)	33.850***
Food secure	22 (88.0)	2 (10.0)	20 (80.0)	
Food insecure	3 (12.0)	18 (90.0)	5 (20.0)	
Mildly	0 (0.0)	0 (0.0)	2 (8.0)	
Moderately	1 (4.0)	2 (10.0)	1 (4.0)	
Severely	2 (8.0)	16 (80.0)	2 (8.0)	

<sup>1)</sup> HFIAS: Household food insecurity access scale<sup>2)</sup> The number of participants who provided information.<sup>3)</sup> Post-hoc multiple comparison by Tamhane<sup>4)</sup> Brown-Forsythe test<sup>5)</sup> Fisher's exact test\*  $P < 0.05$ , \*\*\*  $P < 0.001$ 

Childbirth took place between 1994 and 2003, and most (63.3%) children were born after 1999. Subjects left North Korea between 1996 and 2007 and entered South Korea between 2001 and 2008. A total of 53.8% of subjects left North Korea during the late 1990s and entered South Korea mostly after 2006.

#### Food Security

Average HFIAS score was lowest immediately before leaving North Korea (10.05), whereas HFIAS score (2.62) immediately before childbirth was slightly higher than that immediately before entering South Korea. HFIAS scores at different time points were significantly different ( $P < 0.001$ ). In examining food security status, the majority of the households were food secure immediately before childbirth (70.8%) as well as immediately before entering South Korea (85.4%), but majority was food insecure at the time of immediately before leaving North Korea (73.8%). Food insecure households tended to be severely food insecure as opposed to mildly or moderately food insecure. Differences in food security status between time points were statistically significant ( $P < 0.001$ ) (Table 2).

The food security situation was dependent on place of childbirth (Table 2). Women who had a child in North Korea

reported a low level of household food security with mean scores of around 4.0 in North Korea. No statistical differences were observed between immediately before childbirth and immediately before leaving North Korea. However, food security status of households improved immediately before entering South Korea with a mean score of 0.61 and 91.3% of the households were food secure. In contrast, women who had their child in a nation other than North Korea reported a significantly low level of household food security immediately before leaving North Korea with a mean score of 16.10 and 90% food insecurity. Among these households, the food security situations immediately before childbirth as well as immediately before entering South Korea appeared to be similar.

#### Food consumption

The majority (89.4%) of women reported to having three meals or more per day immediately before childbirth, whereas a lesser proportion (67.5%) of women ate three meals or more per day immediately before leaving North Korea ( $P < 0.05$ ). Similarly, although 51.1% of women reported not consuming snack immediately before childbirth, a great majority (85%) did not consume snacks immediately before leaving North Korea ( $P < 0.01$ ) (Table 3).

**Table 3.** Meals, snacks, and Food Diversity Score of displaced North Korean women

	Immediately before		Statistical test
	Childbirth (n = 47)	Leaving North Korea (n = 40)	
Number of meals a day (n(%))			
1 meal	0 (0.0)	1 (2.5)	6.452 <sup>1)*</sup>
2 meals	5 (10.6)	12 (30.0)	
3 meals or more	42 (89.4)	27 (67.5)	
Snack (n(%))			
Consumed	23 (48.9)	6 (15.0)	11.199**
Not consumed	24 (51.1)	34 (85.0)	
Food diversity score <sup>2)</sup> (M ± SD)	2.17 ± 1.02	1.74 ± 0.83	529.00 <sup>3)</sup>
1 (n(%))	13 (31.7)	15 (44.1)	6.223
2	13 (31.7)	15 (44.1)	
3	10 (24.4)	2 (5.9)	
4	4 (12.2)	2 (5.9)	
5	0 (0.0)	0 (0.0)	
Food group consumption <sup>4)</sup> (n(%))			
Grain	40 (94.6)	35 (100)	0.865
Meat	11 (26.8)	4 (11.2)	2.827
Vegetable	27 (65.9)	20 (57.2)	0.607
Fruit	11 (26.8)	2 (5.9)	5.692*
Milk	0 (0.0)	0 (0.0)	n.a <sup>5)</sup>
Sweet	5 (12.1)	1 (2.9)	2.163

<sup>1)</sup> Fisher's exact test<sup>2)</sup> Food Diversity Score was calculated based on the food groups proposed by the Korean Nutrition Society, excluding the fat and sweets group. The highest score possible is five.<sup>3)</sup> Mann-Whitney's U test<sup>4)</sup> The participants who reported consuming food items from the group are shown.  
<sup>5)</sup> No participants reported having foods from the milk group, and statistical tests were not conducted.\*  $P < 0.05$ , \*\*  $P < 0.01$ 

Food diversity scores were generally low (Table 3), with slightly better scores immediately before childbirth (2.17) compared to immediately before leaving North Korea (1.74). The percentages of women who consumed foods from just one food group were 31.7% immediately before childbirth and 44.1% immediately before leaving North Korea. Consumption of five or more food groups by the women was not observed. Foods from grain group were consumed the most, followed by foods from vegetable group. Meat and fruits group ranked a distant 3<sup>rd</sup> and 4<sup>th</sup>, respectively. Foods from milk and dairy were not consumed by any women.

#### Correlations between food security and food consumption

HFIAS scores were significantly associated with the number of meals ( $P < 0.05$ ) as well as food diversity score ( $P < 0.05$ ) immediately before childbirth. However, only the association between HFIAS and number of meals was significant immediately before leaving North Korea ( $P < 0.01$ ). Snacking was significantly associated with food diversity score ( $P < 0.001$ ) only immediately before childbirth.

## DISCUSSION

This study examined the food security experiences and food consumption patterns of displaced North Korean households based on 51 North Korean women currently living in South Korea. The food security level in North Korea was very stark during the investigated time period, as 50-90% of households could be characterized as food insecure and most were "severely" food insecure. The food security level improved once households moved to a third nation, but food security remained serious with 9-20% of food insecure households. The majority of women reported having three meals a day, and some reported having snacks. However, food diversity score was very low with only two food groups (mainly grains and vegetables).

Food security results confirmed the food shortage situation in North Korea. Since this is the first study reporting the HFIAS scores of North Korean women, it was difficult to confirm the results by comparison with other studies. However, when aggregated according to year, HFIAS scores were much higher during the mid to late 1990s (2-14) compared to the 2000s (0-2) (data not shown), which coincides with previous reports that the food situation was worse in the 1990s [1,29-31]. The food security level immediately before leaving North Korea was worse than that in Tanzania (48.1% of households severely food insecure) [22] or Ethiopia (47.8% of households severely food insecure) [23] determined by HFIAS.

This study asked subjects to recall their recent and somewhat distant past experiences, which raised the question of validity. North Korean women completed the HFIAS questions without any problems during pre-testing and the main study possibly because the HFIAS questions were designed to be very distinct and not easy to forget. For example, one question asked "...did you or any household member go to sleep at night hungry because there was not enough food?" In addition to the fact that HFIAS scores by year showed similar trends with other reports, the significant association between HFIAS results and food consumption patterns added to the validity of the methods used in this study. Therefore, the HFIAS results of this study provide a valid snapshot of the food security experienced by North Korean households.

It should be noted that those who gave childbirth in North Korea were in a worse food security situation around the time of childbirth compared to those who gave childbirth in a third nation. Along with children born in North Korea, children born in a third nation to a North Korean parent are classified as North Korean refugees. Special attention should be paid to those children who were born in North Korea to monitor their nutritional and health status, growth, and development.

With many households experiencing severe food insecurity, the food consumption patterns of North Korean women were extremely simple. Women who were in a food insecure situation reported having only one or two food items per meal, with most being cooked rice (*bab*) or porridge. Further, in most cases, cooked rice was even not made of rice but of corn or potato. Porridge was mostly made of grass (*pul*) with a small amount of grain. Women reported eating the same foods throughout the day in small amounts. That is, vegetables, the 2<sup>nd</sup> most frequently consumed food group, appeared to consist mainly

**Table 4.** Correlations among food security score, number of meals, snacking, and food diversity score

Immediately before childbirth				
	HFIAS	Number of meals	Snacking	FDS
HFIAS <sup>1)</sup>	1 <sup>2)</sup>			
Number of meals	-0.318*	1		
Snacking <sup>3)</sup>	-0.216	-0.214	1	
FDS <sup>4)</sup>	-0.393*	0.053	0.606***	1
Immediately before leaving North Korea				
	HFIAS	Number of meals	Snacking	FDS
HFIAS	1			
Number of meals	-0.465**	1		
Snacking	-0.132	0.145	1	
FDS	0.033	-0.021	0.286	1

<sup>1)</sup> HFIAS: Household food insecurity access scale

<sup>2)</sup> Spearman's rho correlation coefficient

<sup>3)</sup> Snacking behavior was studied as consumed or not consumed.

<sup>4)</sup> FDS: Food Diversity Score was calculated based on the food groups proposed by the Korean Nutrition Society, excluding the fat and sweets group. The highest score possible is five.

\*  $P < 0.05$ , \*\*  $P < 0.01$ , \*\*\*  $P < 0.001$

of wild plants (*namul*). Women who were in a food secure situation reported meals comprising various combinations of rice, soup/stew, kimchi, and side dishes, with fruit as a snack. This might explain why snacking was significantly associated with food diversity score (Table 4). This simple food consumption pattern of grain and vegetables has been reported elsewhere [4].

HFIAS scores were significantly associated with food diversity immediately before childbirth, as expected. However, the association was not significant immediately before leaving North Korea possibly due to severe food insecurity. Before leaving North Korea, 64.3% of women were severely food insecure with a mean score higher than 10. Food consumption pattern at that time was too simple with 44% reporting to having foods from just one food group. That is, the situation immediately before leaving North Korea was so dire that variations required for statistical significance did not appear to exist.

This study has several limitations. First, North Korean women were asked to recall past experiences at various time points. The questionnaire was carefully constructed in terms of the order of questions and the placement of time point indicators. The pre-testing procedure showed that subjects were able to differentiate among the various time points and provided their answers accordingly. In addition, the findings of this study were cross-checked, as described above. Second, this study included only a small number ( $n = 51$ ) of women. Combined with the non-random sampling procedure used in this study, representativeness could be questioned. However, significant associations were detected, which suggests that the size of the sample was not too small for comparing the food security situation with food consumption patterns. Additionally, the difficulty in obtaining data on this population means that any new information is valuable regardless of small sample size.

Despite limitations, this study provides valuable information on food security among North Korean women. Although many have reported on the food shortage in North Korea, this study is one of the few that has specifically examined food security using an internationally recognized food security scale. In

addition, this is one of the first studies to quantify differences in the food security situation of North Korean households at various times and places. Replicating this study using other North Korean households at various time points would allow for a more complete understanding of the effects of food shortage. Further, food diversity scores provide a solid basis for examining changes in food consumption patterns of North Koreans in the process of adaptation to the South. More attention to the changes occurring during adaption to South Korea should be given to understand the process and impact and to prepare public nutrition policy for a re-unified Korea.

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## REFERENCES

1. Food and Agriculture Organization of the United Nations; World Food Programme (IT). FAO/WFP crop and food security assessment mission to the democratic people's republic of Korea [Internet]. Rome: Food and Agriculture Organization of the United Nations; 2011 [cited 2013 Jun 1]. Available from: <http://www.wfp.org/content/dpr-korea-faowfp-crop-and-food-security-assessment-november-2011>.
2. Central Bureau of Statistics (KP). Report on the DPRK nutrition assessment 2002 [Internet]. Pyongyang: Central Bureau of Statistics; 2002 [cited 2013 Jun 1]. Available from: [http://www.unicef.org/dprk/nutrition\\_assessment.pdf](http://www.unicef.org/dprk/nutrition_assessment.pdf).
3. Central Bureau of Statistics (KP). DPRK 2004 nutrition assessment report of survey results [Internet]. Pyongyang: Central Bureau of Statistics; 2005 [cited 2013 Jun 1]. Available from: [http://www.unicef.org/dprk/DPRK\\_nutrition\\_assessment\\_2004\\_p.1-53.pdf](http://www.unicef.org/dprk/DPRK_nutrition_assessment_2004_p.1-53.pdf); [http://www.unicef.org/dprk/DPRK\\_nutrition\\_assessment\\_2004\\_p.54-104.pdf](http://www.unicef.org/dprk/DPRK_nutrition_assessment_2004_p.54-104.pdf).
4. Central Bureau of Statistics (KP). Final report of the national nutrition survey 2012 [Internet]. Pyongyang: Central Bureau of Statistics; 2012 [cited 2013 Jun 1]. Available from: [http://www.unicef.org/eapro/DPRK\\_National\\_Nutrition\\_Survey\\_2012.pdf](http://www.unicef.org/eapro/DPRK_National_Nutrition_Survey_2012.pdf).
5. Choue RW, Hong JY, Yim JE. The changes of dietary intakes in the defectors from North Korea. Korean J Community Nutr 1997;2:470-6.
6. Park YS, Rhee KC, Lee KY, Rhee EY, Yi SH, Kim DN, Choi YS. A glance at the health status and food intake of North Koreans. Korean J Community Nutr 1997;2:396-405.
7. Chang N, Jo D, Hwang J, Kang E. Assessment of health and nutritional status of North Koreans utilizing an exhaustive literature search and survey. Korean J Nutr 1998;31:1338-46.
8. Park YS, Rhee KC, Lee KY, Rhee EY, Yi SH, Kim DN, Choi YS, Seok D. Dietary living in North Korea according to the defectors. Korean J Community Nutr 1999;4:64-73.
9. Chang NS, Hwang JY. Food shortage, nutritional deprivation, and reduced body size in North Korean defectors. Korean J Nutr 2000;33:540-7.

10. Hwang JY, Chang N. Dietary patterns and nutrient intake in North Koreans by utilizing literature search and survey. *Korean J Community Nutr* 2001;6:371-9.
11. Chang N, Kang EY, Lee JM, Lee MK. Anthropometric measurements and dietary patterns of North Korean migrant children in China. *Korean J Nutr* 2000;33:324-31.
12. Shim JE, Yoon J, Jeong SY, Park M, Lee YS. Status of early childhood and maternal nutrition in South Korea and North Korea. *Korean J Community Nutr* 2007;12:123-32.
13. Barker DJ. *Fetal and Infant Origins of Adult Disease*. London: British Medical Journal Group; 1992.
14. Barker DJ. *Mothers, Babies, and Disease in Later Life*. London: British Medical Journal Group; 1994.
15. Gluckman PD, Hanson MA. *Developmental Origins of Health and Disease*. Cambridge: Cambridge University Press; 2006.
16. Ministry of Unification (KR). The statistic of displaced North Korean [Internet]. Seoul: Ministry of Unification; 2013 [cited 2013 Jun 1]. Available from: [http://www.unikorea.go.kr/index.do?menuCd=DOM\\_000000105006006000](http://www.unikorea.go.kr/index.do?menuCd=DOM_000000105006006000).
17. Choi SK, Park SM, Joung H. Still life with less: North Korean young adult defectors in South Korea show continued poor nutrition and physique. *Nutr Res Pract* 2010;4:136-41.
18. Lee SK, Nam SY. Comparison of food and nutrient consumption status between displaced North Korean children in South Korea and South Korean children. *Korean J Community Nutr* 2012;17: 407-18.
19. Coates J, Swindale A, Bilinsky P. *Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide. Version 3*. Washington, D.C.: Food and Nutrition Technical Assistance Project; 2007.
20. Swindale A, Bilinsky P. Development of a universally applicable household food insecurity measurement tool: process, current status, and outstanding issues. *J Nutr* 2006;136:1449S-1452S.
21. Becquey E, Martin-Prevel Y, Traissac P, Dombéle B, Bambara A, Delpeuch F. The Household Food Insecurity Access Scale and an index-member dietary diversity score contribute valid and complementary information on household food insecurity in an urban West-African setting. *J Nutr* 2010;140:2233-40.
22. Knueppel D, Demment M, Kaiser L. Validation of the household food insecurity access scale in rural Tanzania. *Public Health Nutr* 2010;13:360-7.
23. Regassa N, Stoecker BJ. Household food insecurity and hunger among households in Sidama district, southern Ethiopia. *Public Health Nutr* 2012;15:1276-83.
24. Weiser SD, Frongillo EA, Ragland K, Hogg RS, Riley ED, Bangsberg DR. Food insecurity is associated with incomplete HIV RNA suppression among homeless and marginally housed HIV-infected individuals in San Francisco. *J Gen Intern Med* 2009;24:14-20.
25. The Korean Nutrition Society. *Dietary Reference Intakes for Koreans*. Seoul: The Korean Nutrition Society; 2010.
26. Savy M, Martin-Prével Y, Traissac P, Eymard-Duvernay S, Delpeuch F. Dietary diversity scores and nutritional status of women change during the seasonal food shortage in rural Burkina Faso. *J Nutr* 2006;136:2625-32.
27. Arimond M, Ruel MT. Dietary diversity is associated with child nutritional status: evidence from 11 demographic and health surveys. *J Nutr* 2004;134:2579-85.
28. Cordeiro LS, Wilde PE, Semu H, Levinson FJ. Household food security is inversely associated with undernutrition among adolescents from Kilosa, Tanzania. *J Nutr* 2012;142:1741-7.
29. Schwekendiek D. The effect of the seasons of the year on malnutrition in North Korea. *Homo* 2009;60:59-75.
30. Robinson WC, Lee MK, Hill K, Hsu E, Burnham G. Demographic methods to assess food insecurity: a North Korean case study. *Prehosp Disaster Med* 2001;16:286-92.
31. World Food Programme; Food and Agriculture Organization; UNICEF (IT). *Special report: rapid food security assessment mission to the democratic people's republic of Korea* [Internet]. Rome: World Food Programme; 2011 [cited 2013 Jun 1]. Available from: <http://documents.wfp.org/stellent/groups/public/documents/ena/wfp233442.pdf>.